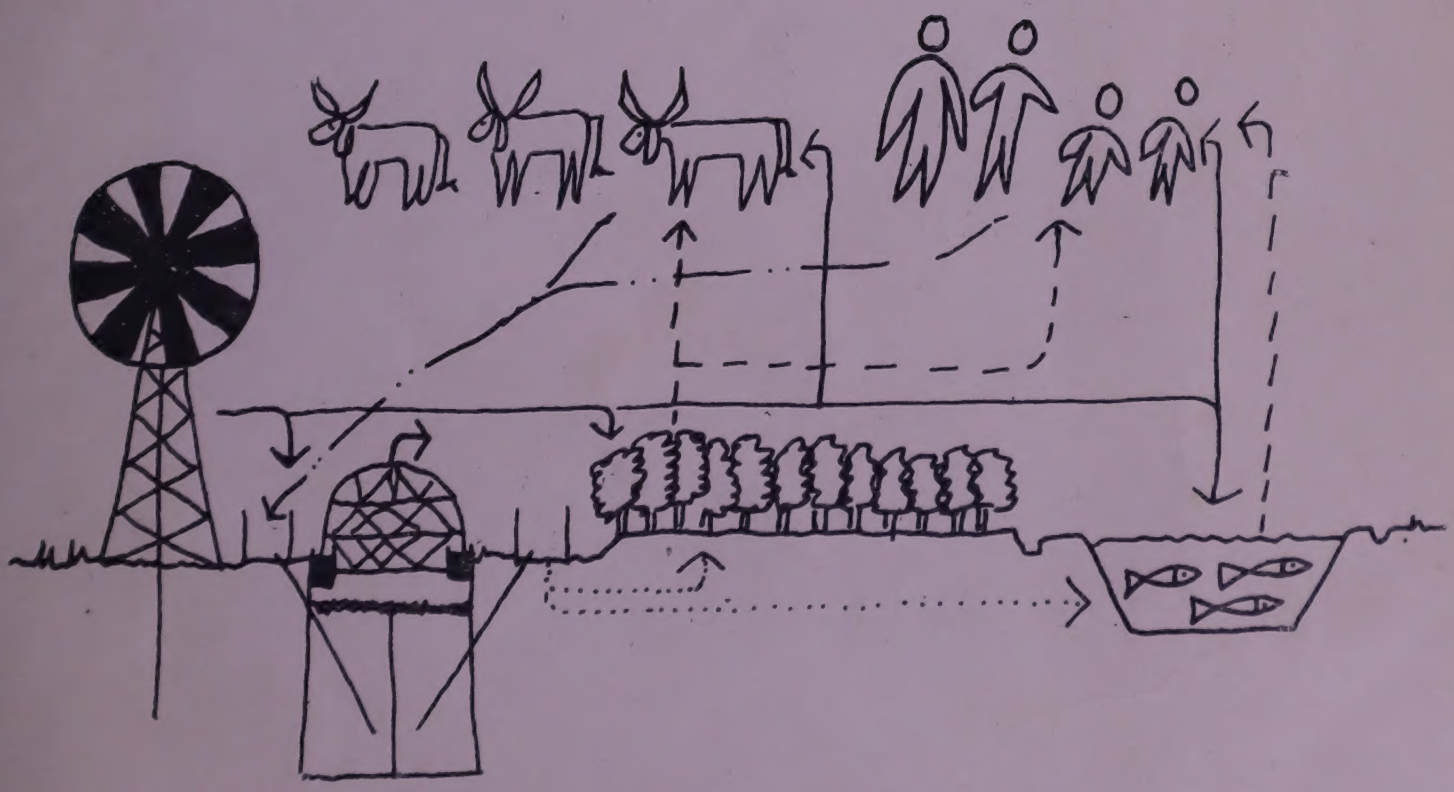
Shri AMM Murugappa chettiar
Research Centre
. photo Synthesis & Energy Division

# Shri AMM Murugappa Chettiar Research Centre

## Photosynthesis & Energy Division



# Technical Notes No 6

# A Three Year Review

# June 1980

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COMMUNITY HEALTH CELL
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India

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TECHNICAL NOTES NO.6 JUNE 1980

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FEEDBACK:

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## 1.0 BACKGROUND

The Photosynthesis and Energy Division of the Shri A M M Murugappa Chettiar Research Centre(MCRC) was established in June 1977 as a no-profit, no-loss research institute funded by the group of companies associated with the name of the late Shri A M M Murugappa Chettiar. MCRC is approved by the Council for Scientific and Industrial Research, the Department of Science and Technology and the Ministry of Finance of the Government of India for the purposes of Income Tax under Clause(ii) Subsection(i) of Section 35 of the 1961 Act.

The overall responsibility of the Centre is vested in the persons of its Board of Governors, who are at present:

1) Shri A M M Arunachalam, Chairman, Industrialist
2) Shri M V Arunachalam, Industrialist
3) Professor S Krishnaswamy, Chairman, School of Biological Sciences, Madurai Kamaraj University
4) Shri M V Murugappan, Industrialist
5) Prof. Y Nayudamma, Distinguished Scientist, Central Leather Research Institute(CSIR)
6) Shri M R R Punja, Executive
7) Prof. M Santappa, Vice-Chancellor, Shri Venkateswara University.

The current organization of the Photosynthesis & Energy Division was conceptualized in 1977 by M M Muthiah and Dr C V Seshadri. The Division's first Director was Dr C V Seshadri who continues to direct the activities of the organization. In the untimely death of Shri M M Muthiah in January 1979 the division lost a close friend and supporter.

Currently, as a member of the Governing Body Shri M V Murugappan is actively involved in the management of the division and in supporting its work and giving direction to its future activities.

## 2.0 BASIC POLICY OF MCRC (P & E DIVISION)

The Division's focus is on the application of Science Technology to solve problems of rural and urban poor. In particular, research and development work is carried out in the areas of renewable energy (solar, wind and biomass), ecological and economic agricultural practices for nutritional and energy self reliance, appropriate technology, health care, social service systems and developmental communications. The specific outputs sought are technologies to enable self sufficiency and self reliance in the production of food, fodder and energy. The division sees as their clientale landless farmers, landless artisans, the tertiary sector and marginal farmers of rural India and the tertiary and informal sections of the urban poor of India.

The Division's frame work can best be described by articulating its belief system, which is:

First development should

- sensitise and allow people to articulate their needs and feelings,

- enable them to critically analyse their environment,

- make people capable of transforming their environment and themselves into more convivial ones of their choice

- help people to meet their basic human needs and enable them to lead economically viable lifestyles that go beyond survival and provide for reasonable security and

leisure,

- encourage co-operative, collective problem solving,

- create self-respect and self-confidence, and,

- create, nurture and rehabilitate their internal capacity to invent and innovate.

and, secondly, science and technology when used as an enabler of development should

- help people to develop scientific attitudes and thinking rather than create "scientists" and "technologists" per se,

- create "tools of thought" that enable people, singly or in collectives to critically analyse their environment and the problems that confront them,

- enable people to define their problems and initiate, create and evolve technology to solve them efficiently, appropriately and in the context of their times,

- help in the answering of basic human needs and go beyond to create an economic surplus,

- make people realise that all things are connected to make them ecologic and holistic in their approach,

- lead to design and evolution of artefacts and methods, to solve problems and answer needs, that are locally fabricatable and which use local resources and skills,

- evolve processes of production that add value locally,

- impact minimally on culture and society in a detrimental fashion,

- be low in cost, high in efficiency and be evaluated in terms of use-value generated per caput,

- be simple as in elegant ( and not as in primitive),

- be accessible and enhance people's abilities rather than oppress.

Science and technology are tools and as such are "mea and not the "end".

Note: For a detailed analysis of the division's polic and frame work please refer to "Technology for Rural Development", Commerce Annual Number,1978 pp. 87-89.

## 3.0 STAFF

### 3.1 Professional Staff:

P Balasubramaniam, Chemical Engineer/Technologist
V Geethaguru, Mechanical Engineer/Technologist
R Manoharan, Microbiologist/Technologist
N Jeeji Bai, Botanist/Technologist
G Raja, Marine Biologist/Technologist
Bhama Rengan, Botanist/CSIR Fellow
Rathindra Nath Roy, Planner/Senior Technologist/Manag
C V Seshadri, Chemical Engineer/Director
V Subramani, Civil Engineer/Technologist
Sebastian Thomas, Botanist/Technologist
B V Umesh, Chemical Engineer/Technologist

### 3.2 SUPPORT STAFF

#### 3.2.1 Administrative Staff:

K Arjunan, Purchase Assistant
S Gandhimani, Administrative Officer

V Krishnamurthy, Administrative Assistant
C Muthunayagom, Administrative Assistant

3.2.2 Community Development Staff:

Nalini Kesavaraj, Community Development Officer
R Kesavaraj, Community Development Officer

3.2.3 Library & Documentation Staff:

M Chitra, Assistant Librarian/Research Assistant

3.2.4 Technical Support Staff:

Technicians 7
Technician's Assistants 19

3.2.5 Maintenance & Security Staff:

Maintenance 4
Security 3

## 4.0 INTERNALLY FUNDED PROJECTS (RESEARCH IN PROGRESS STA REPORT)

| Area of Research | Idea stage | R & D | Prototype | Field testing | Technology transfer | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **4.1 Biotechnology Systems** | | | | | | |
| **Algal Systems:** | | | | | | |
| 1 Identification & separation of algal strains | x | x | | | | x |
| 2 Spirulina culture in inorganic nutrient media | x | x | x | x | x | |
| 3 Spirulina culture in modified media-biogas effluent | x | x | x | x | x | |
| 4 Spirulina culture,biogas effluent + sea-salt | x | x | x | x | x | |
| 5 Spirulina culture,biogas effluent+sea-salt+ bone meal | x | x | x | x | x | |
| 6 Spirulina culture,Biogas effluent+sea water | x | x | x | | x | |

| | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 7 | Culture of Nitrogen fixing algae | x | x | | | | |
| 8 | Culture of SCP-Chlorella & Scenedesmus | x | x | | | | |
| 9 | Algae for pollution control | x | x | | | | |
| 10 | Culture of Azolla/Anabaena for paddy culture | x | x | | | | |
| 11 | Spirulina culture in sewage | x | | | | | |
| 12 | Development of harvesting and processing equipment for Spirulina culture | x | x | x | x | x | x |
| 13 | Wind agitators for Spirulina culture | x | x | x | x | x | x |
| 14 | Feeding trials of cattle and fish with Spirulina | x | x | | x | x | x |
| 15 | Feeding trials of humans with Spirulina incorporation in Puris, Idlis and Sago Waffers | x | x | | | | |
| 16 | Protein estimation in Spirulina incorporated food | x | x | | | | |
| 17 | Nitrogen estimation in Spirulina incorporated food | x | x | | | | |
| 4.1.2 | <u>Microbial Systems:</u> | | | | | | |
| 1 | Culture of Photosynthetic bacteria | x | x | | | | x |
| 2 | Culture of Yeast(Candida utilis) in organic medium | x | x | | | | x |

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 3 Culture of Yeast in digested cattle manure | x | x | | | |
| 4 Culture of Yeast in digested water hyacinth | x | x | | | |
| 5 Harvesting techniques for Yeast | x | x | | | |
| 6 Culture of Trichoderma species in digested hyacinth | x | x | | | |
| 7 Isolation and culture of Nitrogen fixing bacteria from water hyacinth leaves | x | x | | | |
| 4.1.3 Water hyacinth utilization systems | | | | | |
| 1 Methane production from water hyacinth | x | x | x | | |
| 2 Separation of protein from water hyacinth | x | x | x | | |
| 3 Pollution control through water hyacinth | x | x | | | |
| 4 Utilization of water hyacinth stalk for mushroom cultivation | x | x | | | |
| 5 Water hyacinth for cattle feeding | x | x | x | x | x |
| 4.1.4 Pisciculture | | | | | |
| 1 Inland pond mono-culture of Tilapia mossambica | x | x | | x | x |
| 2 Inland pond polyculture of Catla, Rohu, Mrigal & Common Carp | x | x | | x | x |
| 3 Fish feeding trials using Spirulina Algae | x | x | | x | |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 4 Biological control of Tilapia fries | x | x | | x | | |
| 5 Paddy cum Tilapia culture | x | x | | | | |
| 6 Hydroponics and fish culture | x | x | | x | | |
| 7 Inland freshwater Shrimp culture | x | x | | | | |
| 4.1.5 Biogas Systems | | | | | | |
| 1 Low cost biogas plant with Geodesic Dome and LDPE Balloon | x | x | x | x | x | x |
| 2 Community biogas plant using balloon with supporting bamboo structure | x | x | x | x | x | x |
| 3 Biogas run diesel engine trials | x | x | x | | | |
| 4 Combined latrine/biogas project | x | x | x | x | x | |
| 4.2 Wind/Solar Systems | | | | | | |
| 1 ANILA bidirectional horizontal sail wing windmill | x | x | x | x | x | x |
| 2 POGHIL wind seeking horizontal sail wing windmill | x | x | x | x | x | x |
| 3 Pond agitators using savonius rotors | x | x | x | x | x | x |
| 4 Harnessing tree power | x | x | | | | x |
| 5 Solar heaters for parboiling of paddy | x | x | x | x | | x |

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 6 Solar low cost crop and fish driers | x | x | x | x | x |
| 7 Sail type oscillating wind pump | x | x | x | | |
| 8 Solar dunes as heat sources | x | x | | | |
| 9 Solar water heating and sterilizing system | x | x | x | x | |
| **4.3 Food/Fodder/Foresting Systems** | | | | | |
| 1 Biodynamic intensive vegetable gardening | x | x | x | x | x |
| 2 Hydroponics-raft culture in ponds and rivers | x | x | x | x | |
| 3 Small lot energy-food forestry | x | x | | x | x |
| 4 Arid zone farming techniques | x | x | | x | x |
| 5 Energy Plantations | x | x | | x | x |
| **4.4 Appropriate construction systems** | | | | | |
| 1 Low cost pond construction systems to lower evaporation and seepage loss | x | x | x | x | x |
| 2 Geodesic and conical thatch roofing | x | x | x | x | |
| 3 "Hourdi" tile roof for insulation and convection cooling (passive solar cooling) | x | x | x | x | |
| 4 Roof pond aquaculture (passive solar cooling) | x | x | x | x | |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 4.5 Communications | | | | | | |
| 1 ANILA windmill construction manual | x | x | | x | x | x |
| 2 Chinese biogas manual | x | x | | x | x | x |
| 3 Biodynamic garden manual | x | | | x | | |

## 5.0 EXTERNALLY FUNDED PROJECTS

### 5.1 Self-Reliant Development Project (SRD) (1979-1983)

Sponsored by the International Federation of Institutes of Advanced Study and the Murugappa Chettiar Research Centre

MCRC in 1977 was requested to participate in a world network of projects for biological self reliance in rural communities. This was later modified and developed into the Self Reliant Development Project (SRD) funded by the International Federation of Institutes of Advanced Study head quartered in Stockholm, Sweden, and the Murugappa Chettiar Research Centre:

The groups involved in the SRD project and their responsibilities are:

(i) Energy Studies Unit, University of Strathclyde, Scotland. Project Leader: Dr Malcolm E Slesser.
ESU will act as the project coordinating body and provide technical support to develop a dynamic system model to study a biosolar community's self-development potential after a seed-capital contribution,

(ii) Technion, Haifa, Israel - Project Leader: Dr.G.S
Dr Shelef's group will retrofit a community (mos
with biosolar systems and test the technical and
economic feasibility and potential of integrated
energy systems, and,

(iii) MCRC, Madras,India-Project Leader: Dr C V Seshad
MCRC will study the energy, food and fodder syst
of a rural community to estimate the feasibility
and potential of making a rural community self
reliant in food, fodder and energy within five
assuming a seed-capital contribution.

The project has been on-line for a year and hal
the village of Injambakkam, Chinglepattu Distri
of Tamil Nadu and the initial status analysis i
complete. Several technologies have been accep
by the villagers to make the village more self
reliant, among them are windmills, biogas plant
intensive vegetable growing, growing algae for
and poultry feed, aquaculture and sanitation sy
Detailed reports of project activity are publis
as annual reports and are available with MCRC.

5.2 Integrated Rural Food-Energy Systems Project (IRFES)
(1980-81)

Sponsored by the Natural Resources Programme of the
Nations University, Tokyo, and the Murugappa Chettia
Research Centre.

In March 1980 the United Nations University, Tokyo,
through its Natural Resources Programme awarded a
research grant to MCRC to study the feasibility and
nology transfer problems of integrated food-energy
for rural areas.

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Essentially, the project involves selecting five households of different socio-economic strata and studying their food-energy systems in detail at the household level to develop integrated, appropriate technologies that will optimize their resource base utilization and maximize quality of life and income, leading to development.

The project is on-line and five households in different coastal and interior villages of Chinglepattu District of Injambakkam have voluntered for the study. It is hoped that the study will not only give us valuable insights into the domestic and small farm energy systems but also provide a shelf of technologies that households could use to acquire reasonable self reliance in food, fodder, and energy in an economic and ecological manner.

5.3 Solar Panel Analysis (SPA) and Industrial Curing Chamber ICC) Project (1979-80) Pilot Plant Studies in the Mass Culture of Spirulina Algae Project (1980-81). Sponsored by the Coromandel Prodorite Private Limited, Madras, and Murugappa Chettiar Research Centre.

5.3.1 Pilot Plant Studies in the Mass Culture of Spirulina Algae Project (1980-81)

MCRC over the last three years has developed expertise in the Mass Culture of Spirulina Algae as a high protein food/feed supplement for humans, cattle and poultry. It has been convincingly shown that mass culture of Spirulina is possible in village conditions using low cost techniques of pond construction and processing technology and by using low cost, waste-based substitutes for the expensive Zarrouk's nutrient media. The National Dairy Research Institute in Bangalore has begun feeding trials

of Spirulina as a protein supplement, and this has created a regular demand for the algae for feeding. Further, MCRC intends to study the scale and technology problems of mass culture in order to debug the process. Coromandel Prodorite Private Limited have partially sponsored a one year project to develop a 5 kg/day pilot plant to study the technology problem of mass culture, to grow algae for testing as a supplemental protein feed for humans, animals and poultry and to study the use of fibre reinforced plastics (FRP) in biotechnological applications.

The project is on-line and the physical plant is nearing completion at the Tharamani campus. This project takes on special importance considering the following:

(i) Indians are primarily a vegetarian people. Vegetable proteins suffer from a high carbon to nitrogen ratio that reduces their quality for human consumption. Algae with its low C/N ratio and plant origin has a definite role to play in the nutritional development of our people.

(ii) For the first time the cost of protein in Spirulina algae is weight-for-weight comparable to that of other vegetable sources of protein.

The pilot plant uses HDPE lined tanks for mass culture using as nutrient media a combination of biogas effluent, water and a small percentage of Zarrouk's solution. The biogas developed is used to run engines that aerate the ponds, the exhaust heat of which in turn is used to dry the algae. Simple methods of harvesting and drying are used. The plant shows promise as a potential rural activity for food and feed production using waste materials and doing so ecologically and economically.

5.3.2 Solar Panel Analysis (SPA) Solar Industrial Curing Chamber (ICC) and Solar Water Heating Systems (SWHS) Project (1979-80)

Coromandel Prodorite Private Limited have partially sponsored a research project at MCRC to study solar space heating and water heating. The project is an ideal interaction as both MCRC and Coromandel Prodorite Private Limited stand to benefit: MCRC in its development of solar devices for crop drying, fish drying and other low temperature activities and Coromandel Prodorite Private Limited in its possible use in industrial low temperature curing of fibre reinforced plastic products.

Several flat-plate solar space heating devices were designed and tested on location at CPPL to evaluate the temperature profile and the time during which the temperatures would be in the range of 80 to 120°C (which is required for curing). Further, fibre reinforced plastic products were cured for different time periods in the solar heaters and the materials were tested for tensile strength and flexible strength. The idea of solar curing of FRP was found feasible and, in fact, both tensile strength and flexible strength showed improvements over their electric oven cured counterparts by 1 to 2%.

The next stage will be to build a prototype of a full size production solar curing chamber to field test the idea.

In the area of solar water heaters two concepts are at the design stage and work on the prototypes have begun.

The first is a batch-type solar water heating module for domestic and small industrial use to produce water at temperatures in the region of 80°C. The design incorporates an integrated FRP unit with a transparent FRP transmitter (cover), and the water is held between a FRP sheet and a corrugated black FRP sheet.

The second is a parabolic collector (lined with aluminium foil) with a copper tube through its focus point connected to a pressure cooker. The unit is expected to achieve temperatures of 120°C under above-atmosphere pressure conditions. The purpose in mind is to provide low cost sterilization facilities in remote primary health centre.

## 6.0 RESEARCH OUTPUT


1977

1.0 C V Seshadri & M C Misra (1977) "Modes of Feeding Outdoor and Indoor Mass Cultures of Algae", Indian Science Congress, Focal Theme Symposium on Nitrogen Fixation and Photosynthesis, Bhubaneswar, Orissa.

2.0 C V Seshadri (1977) "Engineering of Photosynthetic Systems: A total energy and total materials system using algal cultures", MCRC Monograph Series No.1.

3.0 MCRC Technical Notes No.1 (1977)

4.0 MCRC Technical Notes No.2 (1977)

1978

1.0 Rathindra Nath Roy (1978) "Biomass Conversion, An Ecological Domestic Energy Alternative for Cities", Seminar on Resource Conserving City Planning, Ahmedabad

2.0 Rathindra Nath Roy (1978) "Urban Development, Employment Generation and Conservation", Seminar/Workshop on Slums, HUDA/MCH, Hyderabad.

3.0 V Geethaguru (1978) "Low Cost Ways of Harnessing Wind Energy", Symposium on Appropriate Technology for Rural Development, T.K.M. College of Engineering, Quilon.

4.0 Rathindra Nath Roy (1978) "Towards a Theory of Technology for Rural Development", Annual Board Meeting of the International Federation of Institutes of Advanced Studies, Pune.

5.0 C V Seshadri (1978) "Analysis of Bioconversion Systems at the Village Level", Conference on the State of the Art of Bioconversion of Organic Residues for Rural Communities, UNU, Guatemala City.

6.0 Rathindra Nath Roy (1978) "Technology as a Subversive Activity: Towards a Theory of Harijan Development", Conference on Technological Vectors and Cultural Dynamics, Space Applications Centre, Ahmedabad.

7.0 Rathindra Nath Roy (1978) Synergetics for Development: A Workshop with Buckminister Fuller, VIKSAT, Ahmedabad.

8.0 C V Seshadri (1978) Seminar on Social Communication, British Council, Madras.

9.0 C V Seshadri (1978) "Biomass for Energy", Seminar on Energy, Heat & Mass Transfer, IIT, Madras.

10.0 C V Seshadri & Sebastian Thomas (1978) "Utilization of Industrial Waste Carbon Dioxide for Algal Cultivation", Proc. International Symposium on Environmental Agents and Their Biological Effects, Hyderabad, India, Int-S-4-150-156.

11.0 C V Seshadri & Sebastian Thomas (1978) "Low Cost Cultivation and Processing of Algae Utilizing Solar Energy", Proc. National Solar Energy Convention, Bhavnagar, India, A7 41-46.

12.0 Sebastian Thomas (1978) Participated in a UNEP/UNESCO/ ICRO Course in "Applied Aquatic Microbiology", Israel.

13.0 C V Seshadri & G Venkataramani (1978) "Energy Plantations for the Coromandel Littoral", National Solar Energy Convention, Bhavnagar, India.

14.0 C V Seshadri, G Venkataramani & V Vasanth (1978) "Engineering Of Photosynthetic Systems: Energy Plantations - A Case Study for the Coromandel Littoral", MCRC Monograph Series No.2

15.0 C V Seshadri & M C Misra (1978) "Study of Some Engineering Parameters and the Effect of Harvesting Time in Mass Culture of Algae", International Solar Energy Congress, New Delhi, India.

16.0 Sebastian Thomas (1978) participated in International Conference on Production and Use of Microalgae Biomass, Haifa, Israel.

17.0 MCRC Technical Notes No.3 (1978)

18.0 MCRC Technical Notes No.4 (1978)

1979

1.0 C V Seshadri (1979) "Biochemical Engineering and Appropriate Technology", Seminar on Biochemical Engineering Teaching & Research in India, Jadavpur University, Calcutta.

2.0 C V Seshadri & Rathindra Nath Roy (1979) Symposium on Human Ecology, Madras Christian College, Madras, India.

3.0 C V Seshadri & Sebastian Thomas (1979) "Mass Culture of Spirulina Using Low Cost Nutrients", Biotechnology Letters, 1(7), 287-291.

4.0 Sebastian Thomas (1979) "Biomass: An Alternate Energy for the Third World", U.G.C. Summer Institute on 'Energy Utilization and Waste Recycling', Avinashilingam Women's College, Coimbatore, India.

5.0 Sebastian Thomas (1979) "Energy Utilization and Waste Recycling at Village Level", U.G.C. Summer Institute, Coimbatore, India.

6.0 N Jeeji Bai & C V Seshadri (1979) "On Coiling and Uncoiling of Trichomes in the Genus Spirulina", VIII International Symposium of IAC, Kastanienbaum, Switzerland.

7.0 G Raja (1979) Attended Symposium on Inland Aquaculture, Central Inland Fisheries Research Institute, Barrackpore.

8.0 C V Seshadri (1979) "Processes in Biotechnology Transfer to Rural Communities" with notes on "Algal Systems" (Thomas & Seshadri) and "Biogas Systems" (Seshadri & Thomas), Workshop on "Bioconversion of Lignocellulosic and Carbohydrate Residues in Rural Communities", U N University/Govt. of Indonesia/Govt. of Netherlands, Bali, Indonesia.

9.0 C V Seshadri (1979) "Appropriate Technology-Implications of Life-Style Choices", International Seminar on Science, Technology and Society in Developing Countries, Bombay.

10.0 C V Seshadri (1979) "Analysis of Bioconversion Systems at the Village Level", MCRC Monograph Series No.3.

11.0 Rathindra Nath Roy (1979) "Micro-level Planning of Food, Forage and Energy", Seminar on Food Technology & Development, USICA-RRL/CSIR-AFSI, Trivandrum.

12.0 Rathindra Nath Roy (1979) "R & D Needs in Microlevel Rural Energy Planning", Workshop on Energy for Rural Development, IIM, Ahmedabad, India.

13.0 V Geethaguru & Rathindra Nath Roy (1979) Participated in Seminar on Functional Vehicle Design in the Third World, Max Muller Bhavan - Indo-German Chamber of Commerce, Madras.

14.0 MCRC Technical Notes No.5 (1979)

1980

1.0 Rathindra Nath Roy (1980) "Soft Technology, Hard Choices", The North-South Dialogue Meeting, USICA, Madras.

2.0 Rathindra Nath Roy (1980) "Individual Freedom vs National Security", Chester Bowles Seminar on the Individual and the State, Ooty, Tamilnadu.

3.0 V Geethaguru (1980) Participated in Workshop on Energy for Rural Communities, U N University, Arusha, Tanzania.

4.0 C V Seshadri (1980) "Utilization of Sugarcane for Alcohol", II Ch.E Regional Chapter Meeting, Pune.

5.0 C V Seshadri (1980) International Symposium on Bioconversion of Residues, IIT, New Delhi, India.

6.0 V Geethaguru (1980) attended Training in Alternative Energy Technologies for Developing Countries, USAID, University of Florida, Gainesville.

7.0 C V Seshadri and Sebastian Thomas (1980) "Mass Culture of Spirulina fusiformis using Village Level Technology", paper accepted for International Symposium on Biogas, Microalgae and Livestock Wastes, Taipei, Taiwan.

8.0 Sebastian Thomas and G Raja (1980) Spirulina Algae in

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Rural Pisciculture" paper accepted for International Symposium on Biogas, Microalgae and Livestock Wastes, Taipei, Taiwan.

9.0 MCRC Staff (1980) The Algae-Milk Farm" paper accepted for National Solar Energy Convention, Annamalai Nagar, Tamil Nadu.

10.0 MCRC Staff (1980) "ANILA & POGHIL, Two Low Cost Wind Pumps", paper accepted for National Solar Energy Convention, Annamalai Nagar, Tamil Nadu.

11.0 MCRC Staff (1980) "Roof Pond Aquaculture to Cool Buildings" paper accepted for National Solar Energy Convention, Annamalai Nagar, Tamil Nadu.

12.0 MCRC Staff (1980) "The Madras Roof as a Passive Solar Device" paper accepted for National Solar Energy Convention, Annamalai Nagar, Tamil Nadu.

13.0 MCRC Staff (1980) "Synergistic Protein - Gas Process from Water Hyacinth" paper accepted for National Solar Energy Convention, Annamalai Nagar, Tamil Nadu.

14.0 Rathindra Nath Roy (1980) Participated in Workshop on An Alternate Approach to the Management of Research, Development and Education in Science and Technology, IIM, Bangalore.

15.0 First Annual Report of the IFIAS-SRD Project, (1980) MCRC, Mimeo.

## 7.0 HONOURS AND AWARDS

V Geethaguru and C V Seshadri were awarded the Independence Day Inventions Award of the National Research Development Corporation of India, 1979, for the design and development of the ANILA Windmill.

## 8.0 AFFILIATIONS OF CENTRE MEMBERS TO WORKING GROUPS

C V Seshadri

Member, Experts Panel, Swedish Inventors Association

Member, United Nations University Task Force on World Hunger and Natural Resources

Member, Fuels from Biomass Committee, Department of Science and Technology, Government of India.
Member, State Panel on Energy Forestry, Government of Tamil Nadu.
Member, Experts Panel, Madurai Kamaraj University - Energy Studies Unit.
Member, Editorial Board, Journal of Biomass (London)
Editor, Progress in Bioconversion, Tata-McGraw Hill, Delhi.

Rathindra Nath Roy

Member, Expert Committee on District Science Centres, National Council of Science Museums, Department of Culture, Ministry of Education, Government of India.
Member, N Krishnaswamy Committee on Police Reorganization and Performance of the National Police Commission, Ministry of Home Affairs, Government of India.
Member, in Charge of Research and Documentation, Executive Committee of the Crafts Council of India.

## 9.0 R & D ACTIVITIES

## 9.1 BIOTECHNOLOGY SYSTEMS

### 9.1.1 Algal Systems

MCRC over the last few years has been developing mass culture techniques for Spirulina algae for use as a high protein food/feed supplement for humans, cattle, fish and poultry. Indians as a people are primarily vegetarian. With protein calorie malnutrition in an endemic stage it is crucial to develop low cost protein supplements of a vegetarian nature. Spirulin algae with its low C/N ratio and therefore higher quality of protein is almost an ideal solution especi ally since it has been possible to reduce its cost an make it weight for-weight, protein-wise comparable wi other vegetable proteins.

The conventional method of mass culture is energy and cost intensive as it uses an expensive inorganic medi (Zarrouk's) and needs expensive agitation methods and sophisticated harvesting and processing mechanisms. MCRC's effort to reduce cost and to make the techno- logy simple for assimilation into the rural milieu has been two fold:(1)to substitute the expensive Zarrouk's solution with low-cost, waste based media, and, (2) to develop processing technologies of an app priate nature.

We have developed a medium which has a low percentage of Zarrouk's medium supplemented with digested cattle manure, sea salt and bone meal. This combination is able to avoid micronutrients and many other major nut rients which are primarily responsible for the high cost. The biogas effluent makes the medium optically dense and hence shades the algae from excessive light

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and prevents bleaching. The difference in yield per square metre is quite negligible compared to conventional media. The yield is approximately 11 gms/sq.m/day.

With the availability of labour, intermittent hand stirring with paddles was found adequate. A windmill (Poghil) circulates the medium causing stirring and when necessary the outflow is filtered through cotton cloth (15 to 30 mesh/inch), in simple casurina frames. The harvesting is further simplified as the new medium encourages blooming. Solar driers are used to dry the algae and solar cookers to sterilize it.

The cost of the algae in terms of the nutrient cost is about Rs.4 to 5 a kg, dry weight. At present we are in the process of developing a 5 kg/day pilot plant using improved techniques which, it is hoped, will further reduce the cost.

We are also working with two other food-grade algae and three nitrogen-fixing, fertilizer-grade algae in laboratory conditions. They are: Food Grade - Chlorella and Scenedesmus, and Fertilizer Grade - Nostoc, Tolypothrix and Aulosira. These are being studied in small scale laboratory systems while efforts are being made to develop simple and low cost harvesting methods for food-grade algae, which seems to be the primary block to mass culture at present.

Note:- A monograph on algae describing our effort in detail is expected to be published shortly and will be available from the Documentation Officer of MCRC.

9.1.2 Microbial Systems

MCRC's design of biogas plants incorporates a light-permeable gas holder. This was done to reduce the cost and also to study the possibility of culturing photosynthetic bacteria to enhance the protein content of the sludge, which could then be used as fish feed, in dry flake form. Trials showed that photosynthetic bacteria do grow well in this environment. However, attempts to isolate this bacteria and to culture it in laboratory conditions have eluded us. Research is in progress.

Laboratory culture trials of a single cell protein yeast (Candida utilis) were done in aerobic conditions using conventional MYGP medium and other organic media The organic media studied were based on digested cattle manure and digested water hyacinth. The yields from digested cattle manure were superior to that of MYGP medium with the added factor that the cell size was also larger in the former. Digested water hyacinth trials are in progress. Techniques are being developed for simple harvesting of yeast, and we hope that the larger cell size grown in cattle manure effluent will simplify the process.

With large amounts of water hyacinth available methods were sought to microbially break down the cellulose to simpler sugars to produce feeds. Culture trials of Trichoderma species (fungi) were done on solidified water hyacinth effluent and encouraging results were obtained.

We have been successful in isolating a nitrogen fixing organism from water hyacinth phyllosphere and

attempts are being made to estimate the $N_2$ enfixing capacity and its further utilization on agricultural crops.

9.1.3 Water Hyacinth Utilization Systems

Conventionally water hyacinth has been digested to produce methane. Trials are in progress to extract leaf protein from it. From 1 kg (dry weight) of water hyacinth leaves it is possible to extract 450 litres of biogas and 120 to 160 gms of crude protein concentrate (containing 59% protein).

9.1.4 Pisciculture

Several inland freshwater aquaculture experiments are in progress to study the feasibility of developing fish protein as a food ingredient in rural areas. The experiments are:(1) Monoculture of Tilapia mossambica in naturally manured ponds with groundnut cake as supplementary feed. (2) Culture of Tilapia mossambica under similar conditions with the presence of predators (Clarius Catfish and Ophiocephalus) to control over production of fingerlings, which leads to larger sizes of marketable fish. (3) Polyculture of Catla, Rohu, Mrigal and Common Carp in artificial ponds with Spirulina and groundnut cake as feed supplements to enhance biomass conversion at all trophic levels of the pond ecosystem.

4) Fresh water Shrimp Culture

With Tilapia mossambica's ability to survive in low oxygen conditions and in shallow water, experiments are being run on the feasibility of culturing Tilapia in paddy fields.

MCRC is experimenting with hydroponic systems which grow in heavily manured ponds with low oxygen content This environment can be exploited by certain types of fish (Ophicocephalus). These trials are also in progress.

### 9.1.5 Biogas Systems

MCRC set about simplifying the design and constructio of existing biogas plants with the use of locally available skills, process and materials as the primary constraints.

The MCRC design incorporates a digester which has a cylindrical underground chamber made of brick with a concrete floor. Two cement pipes connect the chamber to the inlet and outlet pits. The lip of the digester has a trench, forming a water trough.

The gas holder consists of a half geodesic dome of woo with a heat welded vinyl balloon inside. The geodesic is anchored in the trough which acts as a water seal (See Figure 1).

The MCRC Biogas Plant on which a new monograph is unde preparation has been installed as follows:

| | | |
|---|---|---|
| Rajapadmapuram Village | : 100 kg/day | cowdung plan |
| Perumal Eri Harijan Colony: | 50 kg/day | " " |
| Vadakadambadi Village | : 50 kg/day | " " |
| Injambakkam Harijan Colony: | 50 kg/day (2 numbers) | " " |
| Tharamani | :100 kg/day (1 plant) | " " |
| | 200 kg/day (2 plants) | " " |

In addition, a community biogas plant based on the same plastic balloon principle is under test.

At current values, the geodesic dome plastic balloon plant is half as expensive as metal dome plants.

The new monograph has all details, and will be available from the Documentation Officer of MCRC.

## 9.2 Food, Fodder and Forestry Systems

### 9.2.1 Algae

The protein in Spirulina was estimated indirectly by first estimating the percentage Nitrogen using the Kjeldahl method, and then multiplying it by 6.25 to give the protein estimate. The protein content of the local Spirulina was found to be approximately 60%. (The indirect method became necessary because of the difficulty encountered in removing pigments from Spirulina to use the Biuret and Lawry Methods). There was no significant difference between protein contents of Spirulina grown in Zarrouk's medium and in MCRC low cost medium.

The National Dairy Research Institute, Bangalore has started feeding trials on our behalf using Spirulina as a supplement. The emphasis is to evolve a suitable calf-starter and also to determine its nutritive value to bullocks.

Feeding trials at MCRC of Tilapia mossambica have shown very promising results. The total biomass fish yields for different feeds is as follows:

Spirulina at 5% level as feed : 9.53 tonnes/ha/9 months

Groundnut cake at 5% level as feed: 6.76 tonnes/ha/9 months

Control (no artificial feeding, only natural: 4.40 to ha/9 months plank

Human feeding trials at MCRC of algae consisted of developing palatable food items incorporating 5 to 10 of algae by weight. In particular Purees (flat wheat dough pancakes deep fried in oil) and Idlis (a ground mixture of rice and lentils, fermented over night and steamed into rice cakes) were experimented with. The Purees tasted very good and the colour change did not bother people. It was found to be palatable. On the other hand the Idlis did not get a good reception. Objection was taken to the green colour (idlis are sn white) and steaming left a mildly fishy taste (which obviously overcome by frying the algae). Several oth foods have been identified which can potentially be supplemented with algae such as Murukkus a favourite snack of South India and Chutneys where the colour would blend in.

### 3.2.2 Cattle Feeding with Water Hyacinth

Most cattle in village India are graze fed; and, with detriorating pasture land (in size and quality) feed has become a serious problem. The question was wheth Water Hyacinth could be used as a feed. Water Hyacinth with its 90% water content if fed fresh tends t bloat the cattle and the weights consumed can be quit deceiving nutritionally. We partially dehydrated the Water Hyacinth in simple solar driers and ran feeding trials in a village situation.

Three dry, pregnant cows were fed variations of combi- nation of dried Water Hyacinth and concentrate ration

and all were grazed normally. After a three month trial the cow with only Hyacinth was in as good a condition as the one with only concentrate. However, the cow with a combination of the two surpassed the others in physical quality of life. The animals found the dried hyacinth palatable and the crude protein content of 26 to 30% of the dry weight seems to have done them good. With the phenomenal growth rate and productivity of Hyacinth this could be a consequential aspect of animal husbandry practices.

### 9.2.3 Biodynamic Intensive Vegetable Gardening

Even the landless poor can have access to at least 10 sq.ms. of land around their dwelling. The question was, could we develop technologies to make this little piece of land productive enough to make a difference.

We have experimented with and have successfully transferred the technology of intensive vegetable gardening. The demand for the idea and the number of people who have started plots of their own makes this one of our more successful areas of technology transfer.

The biodynamic method can be characterised by:

1) Intensive and close-packed cultivation so that plants create their own micro-climate and use very little water.

2) Companion planting and benefitting from the synergy and built-in pest control.

3) Organic manure is used exclusively.

4) No chemical pesticides are used - we used neem leaf extract, made simply by boiling neem leaves in water in a solar cooker.

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5) Double digging of the soil to aid aeration and ro
penetration, and,
6) Planting with the phases of the moon (at the new
moon).

The method is simple and requires almost no resource
unavailable even to the poorest. The yields are qui
spectacular being atleast twice that encountered in
informal, agriculture in villages.

The technique is as follows:-
The soil is soaked with water and allowed to partiall
dry over a couple of days. The top soil of about a
foot is then dug up with a spade, loosened and de-
weeded. The soil is allowed to rest for a day. To
aid aeration and root penetration the soil is then
double dug (See Figure 2). Double digging is done
after adding a layer of farm yard compost-about 24 c
ft. to an area of 100 sq.ft. The seeds are sown a day
or two before the new moon and planted in a close
packed hexagon pattern, alternating the companion
plants. Watering can be done minimally with a spray
can and the only pesticide used was neem leaf extract
(though Pyrethrum and the extract of the Prosophis ma
also be used).

9.2.4 Hydroponic Raft Culture in Stagnant Water

The city of Madras has winding through it two 'rivers
the Cooum and the Buckingham Canal. They are both
essentially stagnant collections of water which play
a major role of collecting organic sewage. They are
a serious health hazard, especially to the slum
dwellers who live on their banks. The question was
could a technology be contemplated that would exploit

the highly manured water surface in a land-scarce area and "clean" up the rivers. If the technology could also generate an income then all the better.

MCRC started trials of hydroponic raft culture to study the feasibility of soil-less cultivation which would satisfy all the problem needs. Rafts of two types were tested. First a bamboo mat attached to a bamboo frame held afloat with PVC fisherman's floats with a thin layer of compost on top. It worked very well and its short life was compensated for by its simplicity and ease of fabrication using local materials at low cost. Secondly, 75 mm diameter PVC pipes heat sealed at both ends and lashed together to form floating mats. It worked well (though not as well as the first type), except that was very expensive and energy intensive. We suggested that people be taught how to make the first variety while some organization could make the latter and rent them out.

Vegetables, rice (IR-20) and Rhodes grass was grown on 1.4 sq.m rafts in a simulated pond at MCRC. The yields were very encouraging for the rice and Rhodes grass.Rice yielded approximately 2929 kgs/ha/130 days, while Rhodes grass yielded an equivalent of 169 tonnes/ha/year in six croppings. Both yields are below that expected on land but have the advantage of not using up valuable land surfaces and fertilizers of any sort. Vegetable plants flourished but for reasons unknown to us yielded stunted vegetables at very low productive rate. The results convincingly showed the potential of a troublesome "resource".

9.2.5 Small Lot Energy-Food Forestry

A well planned forest yields food, fodder and energy quantities that are at least ten times that of the mo intensive agriculture. Forests once established need little or no care and the environmental spin-off is enormous especially in denuded Tamilnadu.

All villages have community land, government land and private land which can be classified as either uncultivable or at best as grazing land. Such poor lands, especially on hill sides and even in water logged area are almost ideal for foresting.

Recently we were approached by a Harijan Co-operative to help them with ideas and we are working out an economically feasible forestry project on land to be leased from the government. Our calculations show that it is possible to economically run a food, fodder, energy fo est and supply these items to the entire region in addition to satisficing the cooperative's own needs. The idea is to lease about one and a half hectares for each family in the cooperative and plant fodder, food a fuel trees of a quick growing type intercropped with vegetables and fodder grass. The capital expenses is taken as a loan from a bank and the feasibility of payback exists. The labour input is minimal and is provided mainly by the women and children. Should the Tamilnadu Government agree to the lease we could see the beginning of a regular forestry movement for the benefit of all.

9.2.6 Energy Plantation

MCRC's initial research effort in Energy Plantation was a study about intense cultivation of Casurina for

generating 100 MWe (installed 160 MWe) in a power plant. The study showed the economic and technical feasibility of the concept.

Following our monograph "Energy Plantations: A Case Study for the Coromandel Littoral", MCRC has done some work with energy plantations on a tiny scale. Mainly this is with pitcher culture of Euphorbia sp. in sandy soil.

The method of cultivation is to plant Euphorbia cuttings around pitchers of water embedded in the soil and covered on top. The pitchers are placed at the centres of close-packed hexagons with the plant cuttings of the species. Once a day the pitchers are filled. The seepage through the walls of the pitchers seems to be enough to keep the plants alive through the initial transplantation shock.

This cultivation is now in its fifth month and there has been about 60% survival among the plants. Many plants were damped by animal and human traffic.

MCRC has been quoted in the Nayudamma Report submitted to Tamilnadu Government for rural employment through energy forestry. The Government is also thinking of starting a feasibility study. On a 1-MW power plant in Ramnad District.

## 9.3 WIND/SOLAR SYSTEMS

### 9.3.1 Anila Bidirectional Horizontal Axis Sail Wing Windmill

### 9.3.2 Poghil Horizontal Axis Down Wind Type of Windseeking Sailwing Windmill

Accessibility to abundant and safe water has been a

crucial variable of development. Water not only deci the quantity and quality of agriculture and animal husbandry but affects the very physical quality of li of people. Villages of Tamilnadu face severe shortag of water. The problem reduces to being able to pump up the ground water and then to store it safely with minimum evaporation and seepage loss. MCRC to answer these felt needs began developing specific technology to answer the various aspects of the problem. To pum up water, MCRC chose to develop wind powered devices which could use the abundant and unidirectional winds encountered by the villages along the 900 km long Coromandel Coast of Tamilnadu, and the multidirection- winds of interior areas.

The Anila windmill is specially designed to utilize t unidirectional coastal winds. The windmill is almost entirely made of materials locally available in villa and small towns and can be fabricated, maintained and repaired by local artisans. The windmill costs Rs.1750/= including labour costs, and pumps up approxi- mately 1500 litres of water from depths upto 6 metres. The windmill can operate at wind speeds as low as 8 km hour but optimally functions at 12 to 15 km/hour (See Figure 3).

The Poghil windmill is designed for interior areas whe wind directions are multidirectional. The Poghil is a simple wind seeking windmill that can be fabricated an maintained by village artisans. The windmill costs Rs.2500/= inclusive of all costs, and pumps up approxi- mately 1500 litres of water from depths upto 6 metres. The wind speeds at which it operates are similar to those of the Anila (See Figure 4).

The Anila and the Poghil can provide sufficient water for a small cluster of households or a marginal farm of less than 2 acres.

A detailed booklet describing the construction of the ANILA is available in Tamil (with English Translation). The document costs Rs.5/= and can be obtained from the Documentation Officer of MCRC. A similar booklet is in the process of production for the POGHIL.

### 9.3.3 Solar Crop and Fish Driers

Fish, vegetables and grains at present are dried on the exposed ground or at best on the roadways, leading to wastage from insect attack, birds and animals feeding on them and due to spoilage (because of long drying periods). MCRC experimented with several types of driers including ones made of ferrocement and soil cement. Finally, the design has been refined to one low cost type that uses only local materials except for transparent polythene sheeting which is available even in small towns. (See Figure 5)

The drier is essentially a large shallow box, with a sloping top so as to catch the sun maximally. The framework is made of casurina or bamboo and the sides are either of gunny sacking or coconut thatch painted over with black paint. It has no bottom section. The top is removable and is a frame with two sheets of transparent polythene.

The matter to be dried is laid out on a sheet of black polyethylence and the frame set on top, the sloping side facing south, and the transparent polythene frame set on top. Ventilation is assured due to porous sides of

gunny and thatch and temperatures of 50 to 60°C are reached. The drier protects the material from pest a animal attack and reduces drying time drastically thu reducing spoilage due to rotting. Dehydration is mor complete and the shelf life of the foodstuffs increas The driers cost less than Rs.100/= to make.

### 9.3.4 Solar Cookers and Water Sterilizers

The effort at MCRC in the area of solar cookers has been essentially in the non-cooking area. Solar cook for domestic cooking are efficient but unfortunately don't really 'fit' into the life-styles of most rural people, and further there is the factor of cost. It i difficult to justify a major expenditure where at pres ent one can build oneself a wood stove for nothing an scavenge wood at personal energy cost. The potential exists but it will be in the future and may require mobilization to change lifestyles and habits.

We have designed large cookers to parboil paddy which at present consumes large amounts of wood and rice hu The unit is a standard cooker with double glazing of glass and an insulated chamber. The variations experi mented with were the use of different locally availabl insulation materials like saw-dust and hay and even the structural use of hollow brick tiles where the air gaps were stuffed with insulation material provided insulation at low cost. All the sterilization of alg grown at the centre is done in our solar cookers at temperatures upto 120°C.

We are at present working on water sterilizers to help out remote Primary Health Centres to get sterile water for feeding of little children and to sterilize

instruments (see Section 5). A small sample cooker with wooden sides and double glass on top with saw-dust and gunny insulation is being used to provide 10 litres of boiled water at a time for one family's demand for water for children below five years of age, who are particularly prone to diarrhoea. The efficiency is enhanced by using a tea chest liner (of metalized poly) to concentrate the heat.

## 9.4 Appropriate Construction Systems

### 9.4.1 Appropriate Pond Construction

The problem was to develop pond construction methods that would suit the needs of drinking water storage, inland aquaculture and algae culture. The specific requirements were to lower evaporation loss and seepage loss and in the case of algal culture ponds it was also necessary to create surfaces that would not react with the nutrient medium and allow for thorough cleaning.

Several low cost methods were developed of which two seem to hold promise especially due to their low cost. The method is as follows: After excavation the pond surface is coated with a 1:1 mixture of clay and river sand. A bund is also built around of the same material. A 1 cm layer of river sand is layed at the bottom of the pond and the entire pond covered with low density polyethylene sheeting of 1000 gauge thickness. The LDPE sheeting is tucked over the bunds and fastened with spikes and covered with soil and turfed over. This is the first type ideally suited for algal cultures. In the second type suited for water storage and fish ponds the same as above is done except that the sheeting is further protected with one layer of country bricks and mortar (See Figures 6 & 7)

The ponds cost, depending on size, between Rs.15/sq.m to Rs.45/sq.m. To avoid thermal cracking and plant matter from growing through the ponds should always b filled with water. The poly covered tanks have to be carefully used to prevent damage; tools used should b covered with a layer of foaming.

9.4.2 Passive Solar Building Techniques

The Centre is housed in three buildings each using a specific type of passive solar roofing device for climate control.

a) Roof Pond: The rest and recreation building consisting of the dining room, kitchenette, ladies and gents toilets and shover rooms has aquaculture ponds built onto the roof. The water acts as a thermal energy store. Control is effected by positionirg coconut tha covers over the ponds. The covers are left open at night to take advantage of night time rediation and convection, whilst during the day the covers are close to protect the water from heat input, allowing the coo water to absorb heat from the living space (See Figure Using the ponds for fish culture has been shown to be feasible and can prove of valuable use in regions wher land is scarce.

b) Insulation-cum-Convection Cooling Using Hourdi Tiles: The office and library building uses large hollow tile sloped at the solar latitude (13°) with the hollow sections placed axially allowing flow of air through the entire roof. Upper parts of the roof are painted black while the lower parts white to ensure a differential temperature which causes air to be sucked in through the roof. The cooling of the building is thus

not merely by air insulation but also by convection cooling. The tile roof with RCC beams to hold it up costs only a fraction of a regular RCC roof(See Figure 9).

c) The laboratory building has a standard flat Madras masonary roofing using Hourdi tiles and is used as the control to study passive solar cooling of buildings.

9.4.3 Pond Roofing

To eliminate evaporation losses and to physically prevent pond pollution thatched roofing was used to cover ponds. Additionally the insides were lined with used plastic fertilizer bags to keep out dust. A simple bamboo geodesic dome and a casurina conical roof were built and thatched with favourable results. The extreme precision required in geodesics caused problems with local artisans who preferred the conical roof structures and their more "tolerant" measurements.

9.5 Communication Systems

At MCRC the effort is to develop technologies that will enable people to conceptualize design, fabricate, maintain, repair and if necessary modify technologies themselves. Our experience is that developing 'appropriate' technology is just a part of the effort and often a small part that is vulnerable to management in most cases. The major aspects, of which little is known seem to be the methodologies of trnasfer of technology which includes communicating the technology and developing the socio-economic infrastructure to enable people to assimilate the technologies into their lifestyles in a convivial manner.

Our analysis has helped us to delineate the process into

distinct communication areas based on the type of in
mation to be transferred and the complex interplay
of variables involved. The first area is one of mak
people aware of facts and inter-relationships and mo
vating them towards specific decision sets. In this
area we find that the one-on-one technologist-end
user interaction is the best transfer mode. Unfortu
nately the numbers make this method impossible to
implement. Thus we are left with distance learning
methods and aids which can be used by extension work
and catalytic persons in the community. The content
tends to be general in nature and concentrates on
communicating new facts and giving a system-understa
ing emphasizing interactions and inter-relationships

The second area of communications is to enable peop
to design and fabricate technology. The content her
is more specialized and visuals take on great import
ance. Communication has to take into consideration
the existing shelf of skills available with the end
user. This area is a difficult one (and the existin
literature on functional literacy and the miserable
failure of manuals that accompany technical artefact
and are supposed to help in assembly and maintenance
will give one an idea of how much!).

The Third area is the most difficult of all and is
to help people to trouble-shoot and set right equip-
ment. The problem here is not merely of having a
language to say it in but the very way of saying it.
This area is a problem even with literate, technolog
cally oriented populations.

The three areas specified are further made difficult
by the fact that the end users we have in mind are

usually illiterate and often have a completely 'different visual framework' which makes the use of symbols and visuals a tricky job.

A small effort has been made in this area: In collaboration with the National Institute of Design, Ahmedabad a do-it-yourself windmill construction manual was developed in a comic book form. This is at present being field tested. Further, two village artisans have written and illustrated two pamphlets, essentially, describing their own experiences of the process of building a Chinese Biogas Plant and creating Intensive, Biodynamic Vegetable Gardens.

A two year project is being planned to undertake twelve modules of "communication of technology" using various modes of learning and instructional technology.

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